Opinion Summarization Using Entity Features and Probabilistic Sentence Coherence Optimization

(UIUC at TAC 2008 Opinion Summarization Pilot)

Nov 19, 2008

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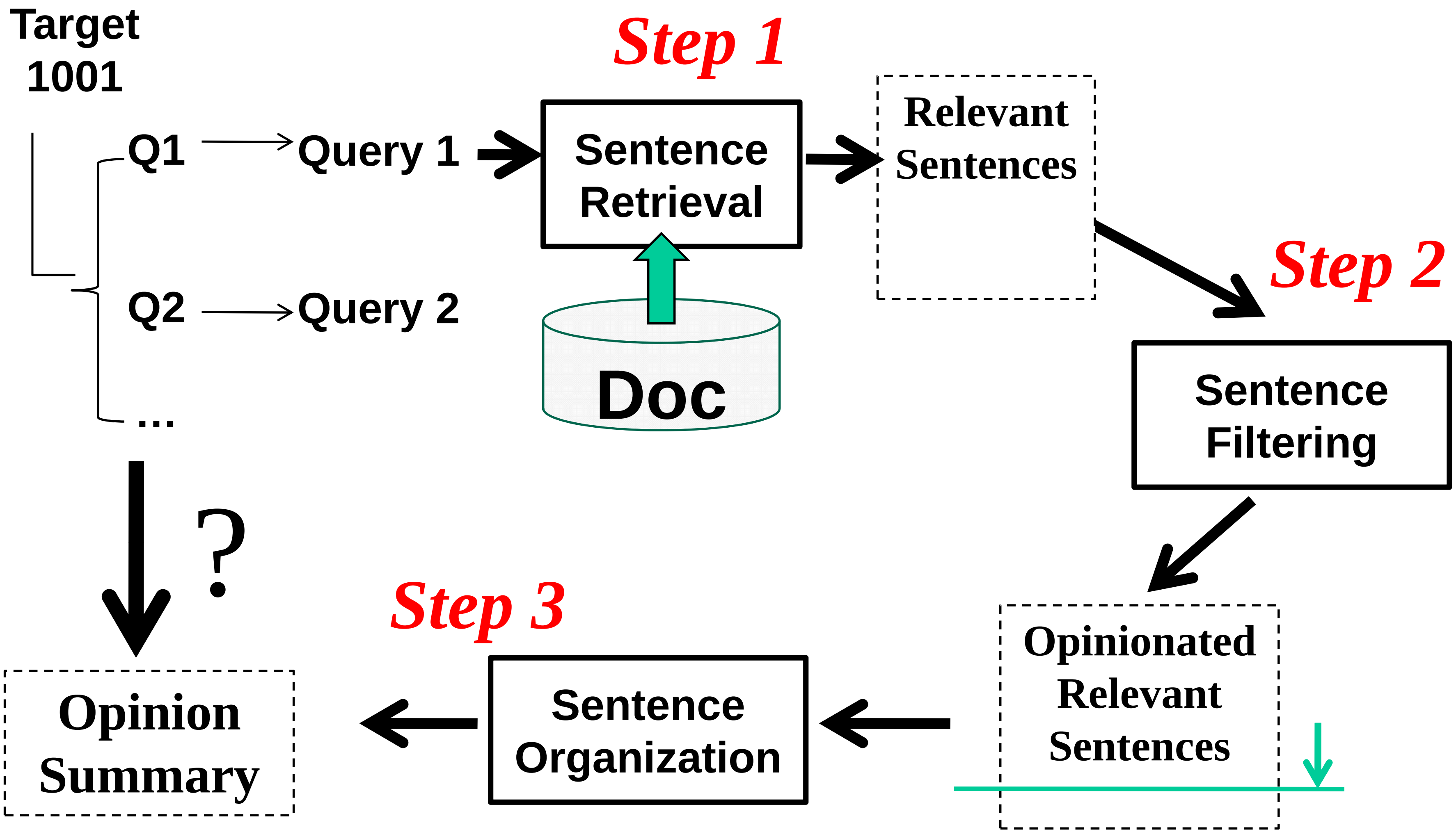
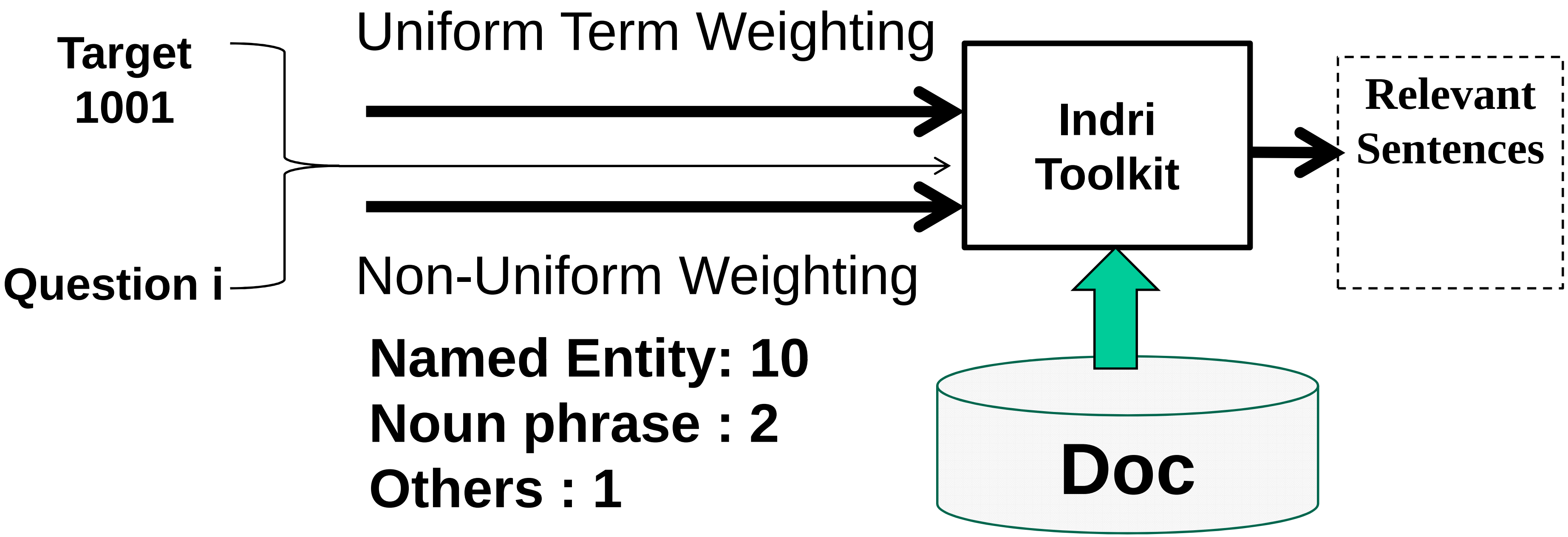
Research Questions

1. Can we improve sentence retrieval by assigning more weights to entity terms?
2. Can we optimize the coherence of a summary using a statistical coherence model?

General Approach



Step 1: Sentence Retrieval



Step 2: Sentence Filtering

Relevant Sentences	Keep only **Opinionated** Sentences	Keep only the **same polarity**	**Remove redundancy**
S1	S1	S1	S1
S2	~~S2~~	~~S2~~	~~S2~~
S3	S3	S3	S3
S1’	S1’	S1’	~~S1’~~
S2’	~~S2’~~	~~S2’~~	~~S2’~~
S4	S4	~~S4~~	~~S4~~
S6	S6	S6	S6
S7	S7	S7	~~S7~~
S4’	S4’	S4’	~~S4’~~

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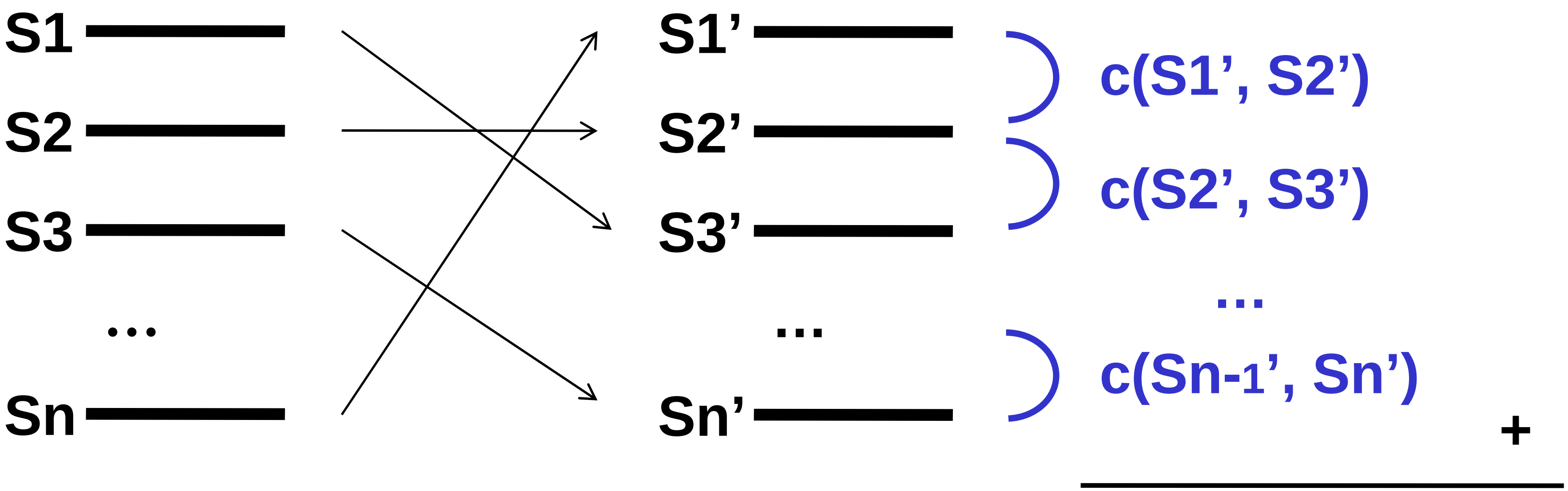
Step 3: Summary Organization
(Method 1: Polarity Ordering)

– **Paragraph structure by question and polarity**
– **Add guiding phrase**

The first question is …
Following are positive opinions…
Following are negative opinions…
The second question is …
Following are mixed opinions…
…

Step 3: Summary Organization

(Method 2: Statistical Coherence Optimization)



- Coherence function: $c(S_i, S_j)$
- Use a greedy algorithm to order sentences to maximize the total score

$$c(S_1', S_2') + c(S_1', S_2') + \ldots + c(S_{n-1}', S_n')$$

Probabilistic Coherence Function

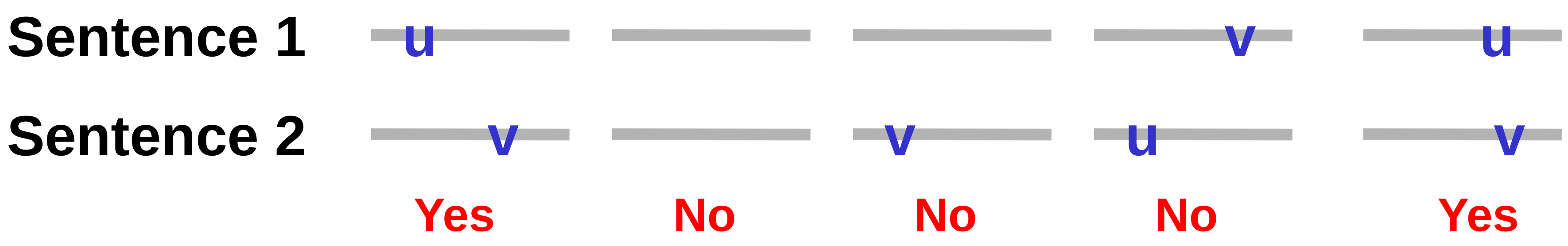
(Idea similar to [Lapata 03])

$$c(s_i, s_j) = \sum_{u \in s_i, v \in s_j} \frac{p(u,v)}{|s_i||s_j|}$$

Average coherence probability (Pointwise mutual information) over all word combinations

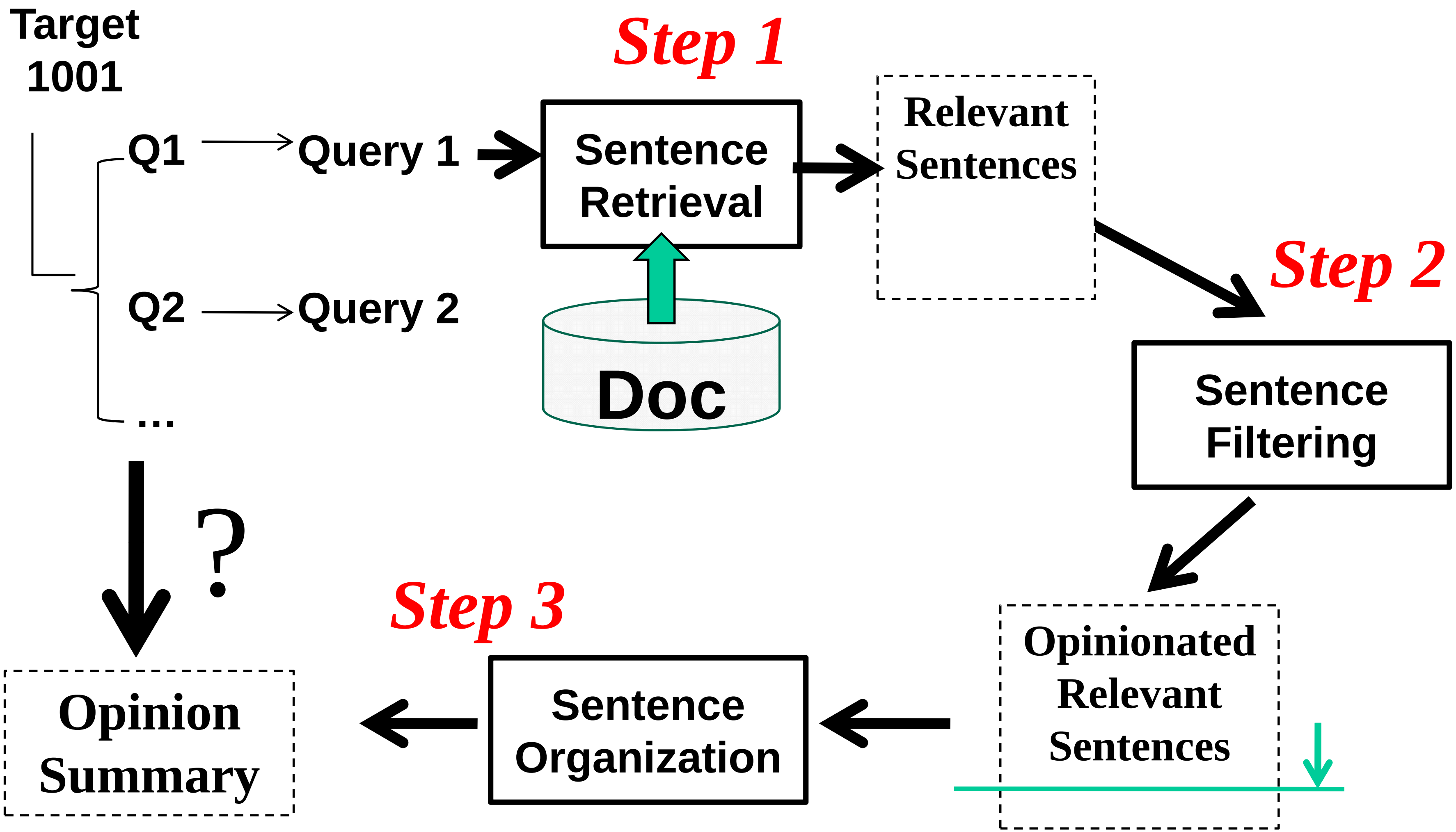
$$\hat{p}(u,v) = \frac{count(\text{"}u \text{ and } v \text{ in two adjacent sentences"}) + 0.001}{count(u) \cdot count(v) + 1.0}$$

Train with original document

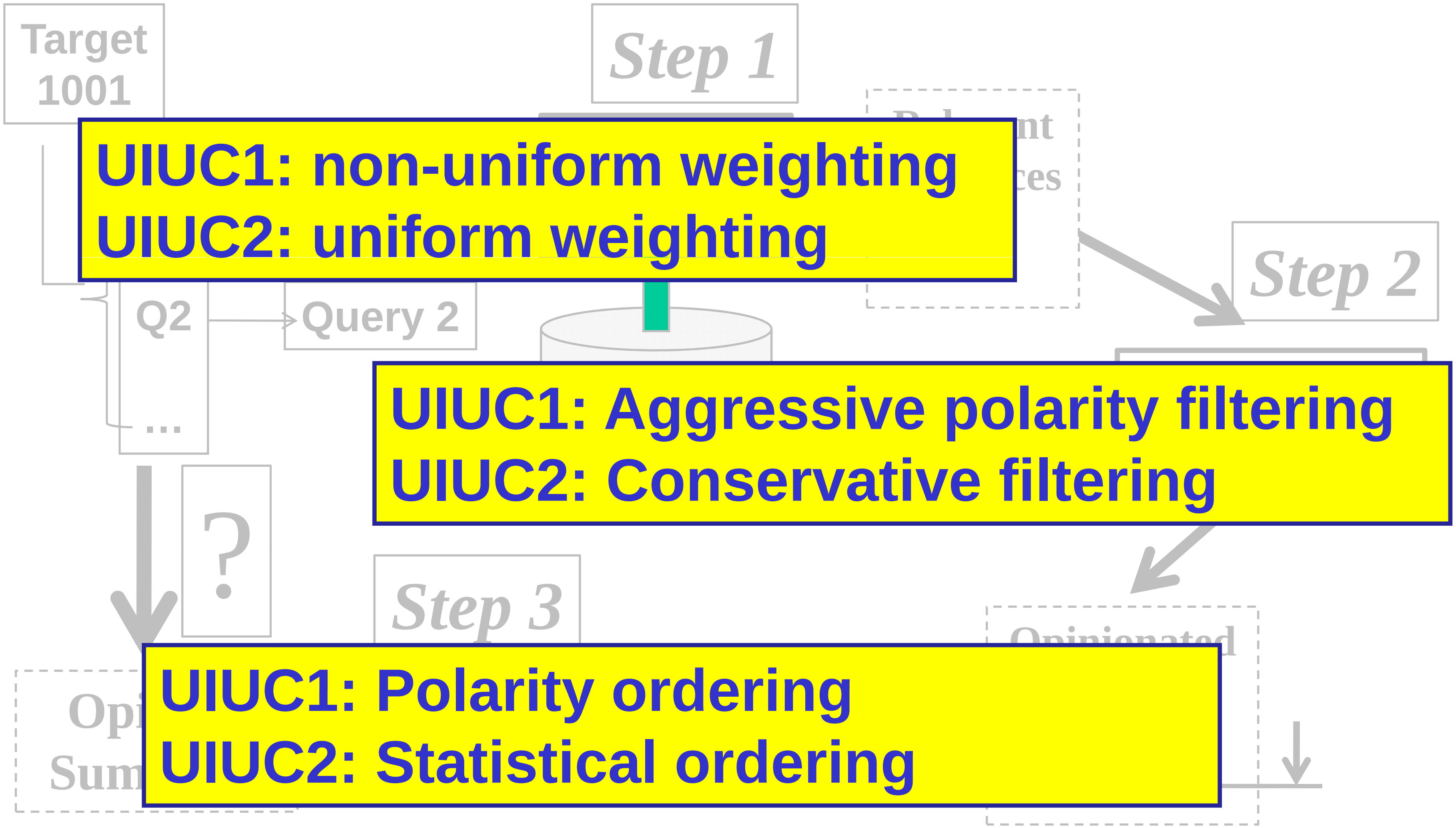


P(u,v) = (2+0.001)/(3*4+1.0)

General Approach



Submissions: UIUC1, UIUC2



UIUC1: non-uniform weighting
UIUC2: uniform weighting

UIUC1: Aggressive polarity filtering
UIUC2: Conservative filtering

UIUC1: Polarity ordering
UIUC2: Statistical ordering

Evaluation

- **Rank among runs without answer-snippet**

(Total: 19 runs)

	F-Score	Grammaticality	Non-redundancy	Structure/ Coherence	Fluency/ Readability	Responsiveness
UIUC1 Polarity	6	15	15	**5**	6	8
UIUC2 Coherence	**3**	9	10	15	16	**4**

Evaluation

- R … without

NE/NP retrieval, Polarity filtering

Polarity ordering

(Total: 19 runs)

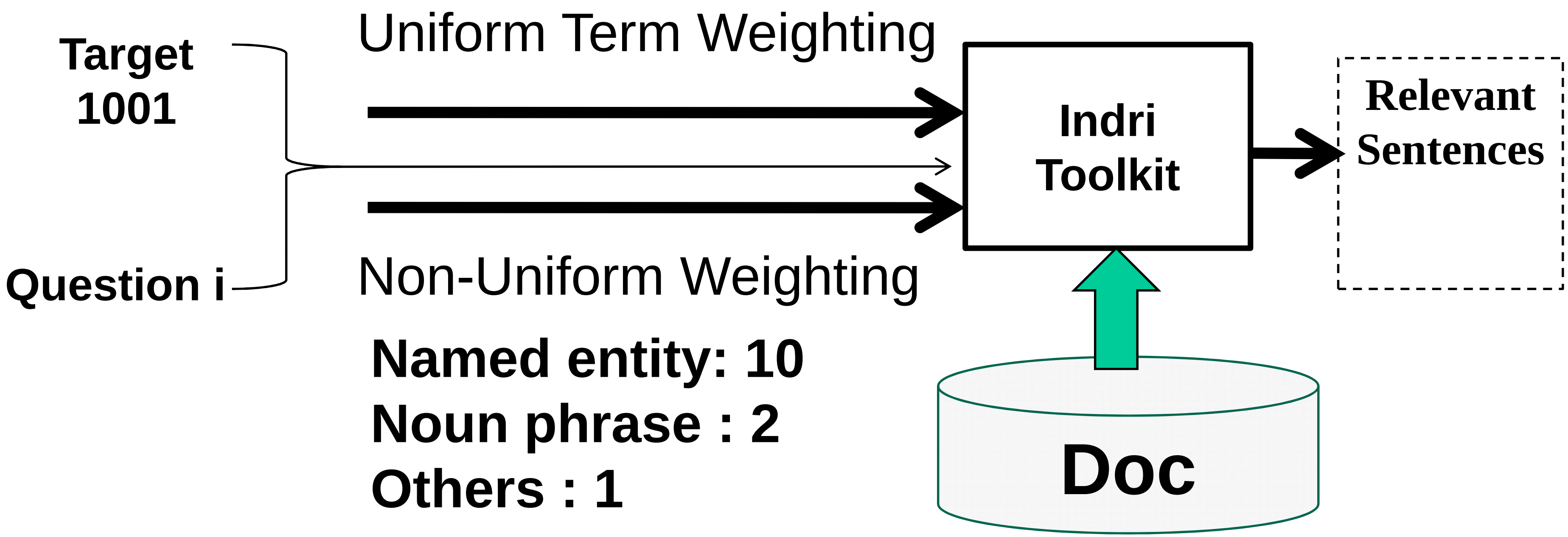
	…core	Grammaticality	Non-redundancy	Stru…e/ Cohe…nce	Fluency/ Readability	Responsiveness
UIUC1 Polarity	6	15	15	**5**	6	8
UIUC2 Coherence	**3**	9	10	15	16	**4**

Nothing

Statistical ordering

Evaluation of Named Entity Weighting

Assume a sentence is relevant iff
similarity(sentence, nugget description) > threshold



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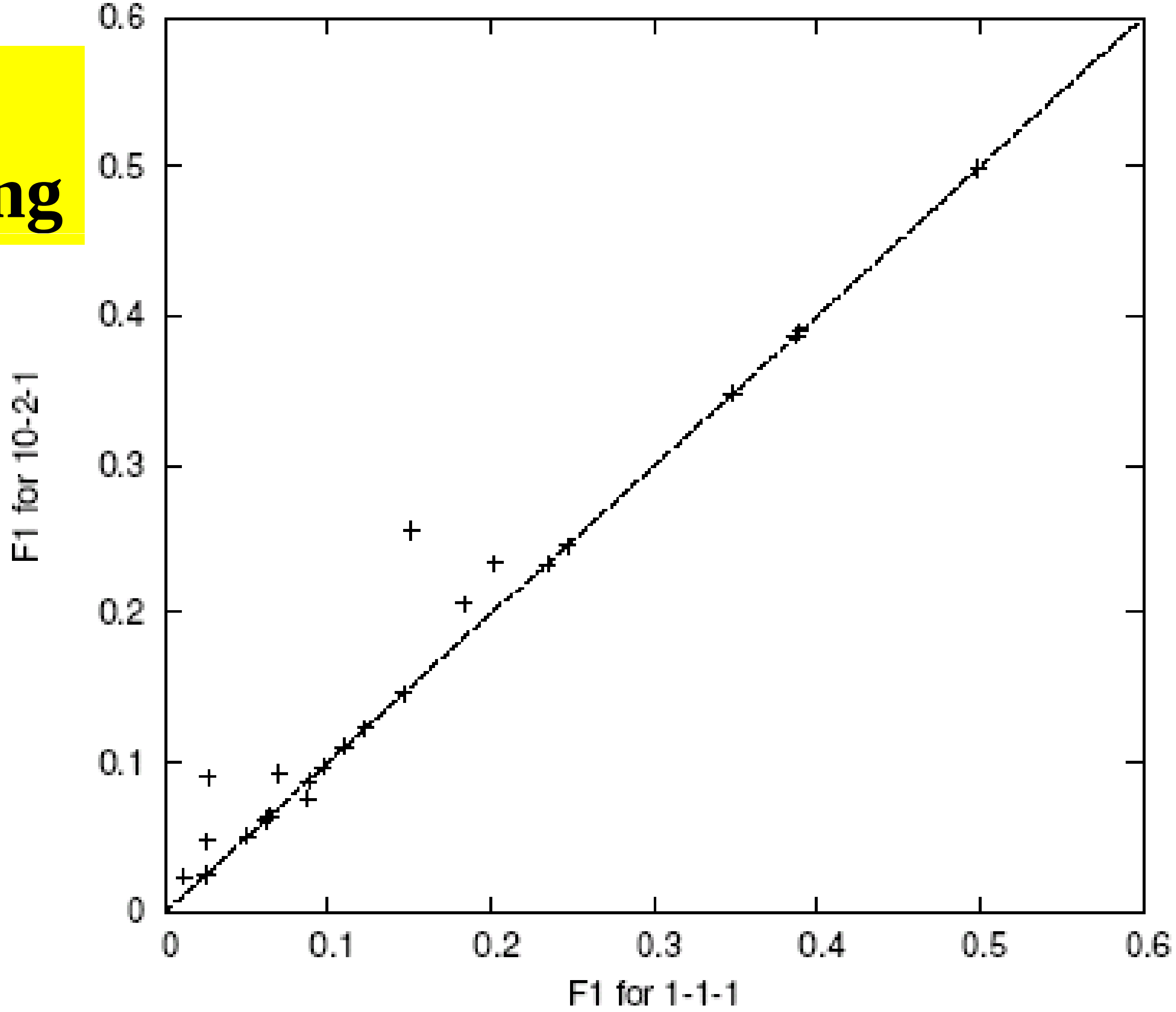
Effectiveness of Entity Weighting

10-2-1 Weighting



1-1-1 Weighting

Polarity Module

- **Polarity module performance evaluation on the sentiment corpus. [Hu&Liu 04, Hu&Liu 04b]**

(Unit: # of sentence)

Classification result	Positive	Negative
NonOpinionated	1063	598
Positive	1363	371
Negative	383	412
Mixed	296	210
Total	**3105**	**1591**
Exact Match	**1363/3105=0.44**	**412/1591=0.26**
	(1363+412)/(3105+1591)=0.38	
Exact Opposite	**383/3105=0.12**	**371/1591=0.23**
	(383+371)/(3105+1591)=0.16	

Coherence optimization

- **Evaluation methods**
  - **Basic assumption**
    - **the sentence order of original document is coherent**
  - **Among given target documents,**
    use 70% as training set, 30% as test set.
  - **Measurement: strict pair matching**
    - **# of correct sentence pair / # of total adjacent sentence pair**

Probabilistic Coherence Function

$$c(s_i, s_j) = \sum_{u \in s_i, v \in s_j} \frac{p(u,v)}{|s_i||s_j|}$$

Average coherence probability over all word combinations

Point-wise Mutual information with smoothing

$$\hat{p}(u,v) = \frac{count("u\ and\ v\ in\ two\ adjacent\ sentences") + 0.001}{count(u) \cdot count(v) + 1.0}$$

Strict joint probability

$$\hat{p}(u,v) = \frac{count("u\ and\ v\ in\ two\ adjacent\ sentences") + 1}{"total\ count\ of\ word\ pairs" + (dictionary\ size)^2}$$

Probabilistic Coherence Function

Mutual information

$$\hat{p}(u,v) = p(u,v)\log(\frac{p(u,v)}{p(u)\,p(v)}) + p(not\,u,v)\log(\frac{p(not\,u,v)}{p(not\,u)\,p(v)})$$

$$+\, p(u,not\,v)\log(\frac{p(u,not\,v)}{p(u)\,p(not\,v)}) + p(not\,u,not\,v)\log(\frac{p(not\,u,not\,v)}{p(not\,u)\,p(not\,v)})$$

where,

$$p(u,v) = \frac{c(u,v)+0.25}{N+1},\ p(not\,u,v) = \frac{c(not\,u,v)+0.25}{N+1},$$

$$p(not\,u,v) = \frac{c(u,not\,v)+0.25}{N+1},\ p(not\,u,not\,v) = \frac{c(not\,u,not\,v)+0.25}{N+1},$$

N = c(u,v)+c(not u, v)+c(u, not v)+c(not u, not v)

For unseen pairs, p(u,v)=0.5*MIN(seen pairs in training)

Coherence optimization test

Selection of training words	Strict Joint Probability	Mutual Information	Pointwise Mutual Information
No Omission	0.022259	0.041651	**0.056063**
Omitted stopwords	**0.031389**	**0.054554**	**0.057119**
Omitted frequent words (counts > 33)	**0.031389**	**0.051460**	**0.049498**
(counts > 11)	0.027013	0.045725	0.046103
(counts > 6)	0.020448	0.032219	0.034785
(counts > 2)	0.019769	0.022259	0.021882
Omitted rare words (counts < 33)	0.022259	0.032898	0.044065
(counts < 14)	0.022033	0.032823	0.049045
(counts < 6)	0.021203	0.037048	0.054931
(counts < 2)	**0.022259**	**0.041802**	**0.056591**

– **Pointwise mutual information effectively penalize common words**

Coherence optimization test

- **Top ranked p(u,v) of strict joint probability**

u	v	p(u,v)
the	the	1.75E-003
to	the	1.22E-003
the	to	1.21E-003
the	of	1.14E-003
the	and	1.14E-003
of	the	1.13E-003
and	the	1.12E-003
a	the	1.06E-003
the	a	1.06E-003
…	…	…

  - **A lot of stopwords are top-ranked.**

Coherence optimization test

Selection of training words	Coherence score
Baseline: random order	0.01586
Strict Joint Probability	0.04308
Mutual Information	0.041651
Pointwise Mutual Information (UIUC2)	**0.056063**
Omitted stopwords	**0.057119**
Omitted non-stopwords	0.020750
Omitted 95% least frequent words (counts < 33):	0.044065
Omitted 90% least frequent words (counts < 14):	0.049045
Omitted 80% least frequent words (counts < 6):	0.054931
Omitted 60% least frequent words (counts < 2):	**0.056591**

- **Pointwise Mutual information was better than joint probability and normal mutual information.**
- **Eliminating common words, very rare words improved performance**

Conclusions

- **Limited improvement in retrieval performance using named entity and noun phrase**
- **Need for a good polarity classification module**
- **Possibility on the improvement of statistical sentence ordering module with different coherence function and word selection**

Thank you

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